QCD tools for future ep/eA colliders

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POETIC 2016

November 17, 2016

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Goals of the panel

- Bring together HEP and NP communities to discuss possible measurements at a future EIC that are of joint interest
- Discuss the pQCD, EFT, and Monte Carlo tools developed for LHC physics that may help interpretation of EIC analyses

Tentative format:

- Begin with questions/discussions prepared by the panel
- Open the floor to audience topics/questions afterwards

However, feel free to contribute at any time!

Broad topics

1. Proton structure from jet measurements
2. Status of parton showers for EIC physics, and showers in media
3. EFT tools for EIC physics
4. Precision needs for PDF fits

Pre-question

Why are HEP people interested in the EIC physics program (or why should they be)?

Discussion points:

- Universal picture of hadronization from ep, ee and pp
- Assist in LHC discoveries by improving high-x PDFs
- Intrinsic interest in understanding higher-twist properties of proton not accessible at the LHC
- Location, location, location

What can we learn from jet production at an EIC?

What can we learn from jet production as compared to single-hadron production?

Discussion points:

- What is a jet at the EIC? Is it the same as an LHC jet?
- Polarized PDFs and gluon spin from jets at EIC and RHIC, but is pQCD under control? Are scale uncertainties a limiting factor (or will they become one)?
- Jets are complementary to hadrons, since there is no fragmentation function uncertainty. Will EIC get to high enough pT to use both SIDIS and jets in PDF fits?

How well-developed is the formalism for calculating pQCD corrections to higher-twist properties of the proton?

Discussion points:

- NLO is known for some spin-dependent twist-3 quantities, and limited twist-4, but are the evolution equations known more generally?
- Can automated HEP tools (such as Madgraph) help in the calculation of these complicated quantities?

What are the prospects for an alphas measurement at the EIC?

Discussion points:

- Large difference amongst various fits, can EIC help with this? Lingering issue for Higgs cross section!
- Stringent theory needs: $N^3LL+NNLO$, or maybe even N^xLL+N^3LO. Is it possible, can we quantify need?
- Joint fit of PDFs, alphas, non-perturbative soft function needed?

What EFT tools developed for the LHC, or elsewhere, can help at the EIC?

Discussion points:

- Many jet substructure tools have been developed for LHC: improved quark/gluon discrimination possible, amenable to precision theory calculations. Are there "killer apps" for these tools at the EIC?
- Are further theoretical developments of for SCET in nuclear media needed? Soft function effects?
- Global analyses for J/Psi show issues between pp/ep collisions; can EIC help resolve?

How well-developed are parton shower Monte Carlo tools for nuclear collisions?

Discussion points:

- Broad QCD program at EIC: one tool/calculation won't do everything!
- How should BFKL evolution/saturation be incorporated?
- Can we use tools like Pythia to hadronize cross sections at the EIC?

Will we be able to approach the HERA/LHC accuracy on polarized PDFs?

What is missing for a NNLO fit of polarized PDFs (and is it interesting)?

Discussion points:

- What is the role of SIDIS versus jet production?
- Do we know what SIDIS distributions can constrain what data sets?
- Should we pursue joint fits of PDFs/fragmentation functions/higher-twist proton properties?